THE DRIVERS OF PATENT ACTIVITY IN CHINA

Gary H. Jefferson
Brandeis University
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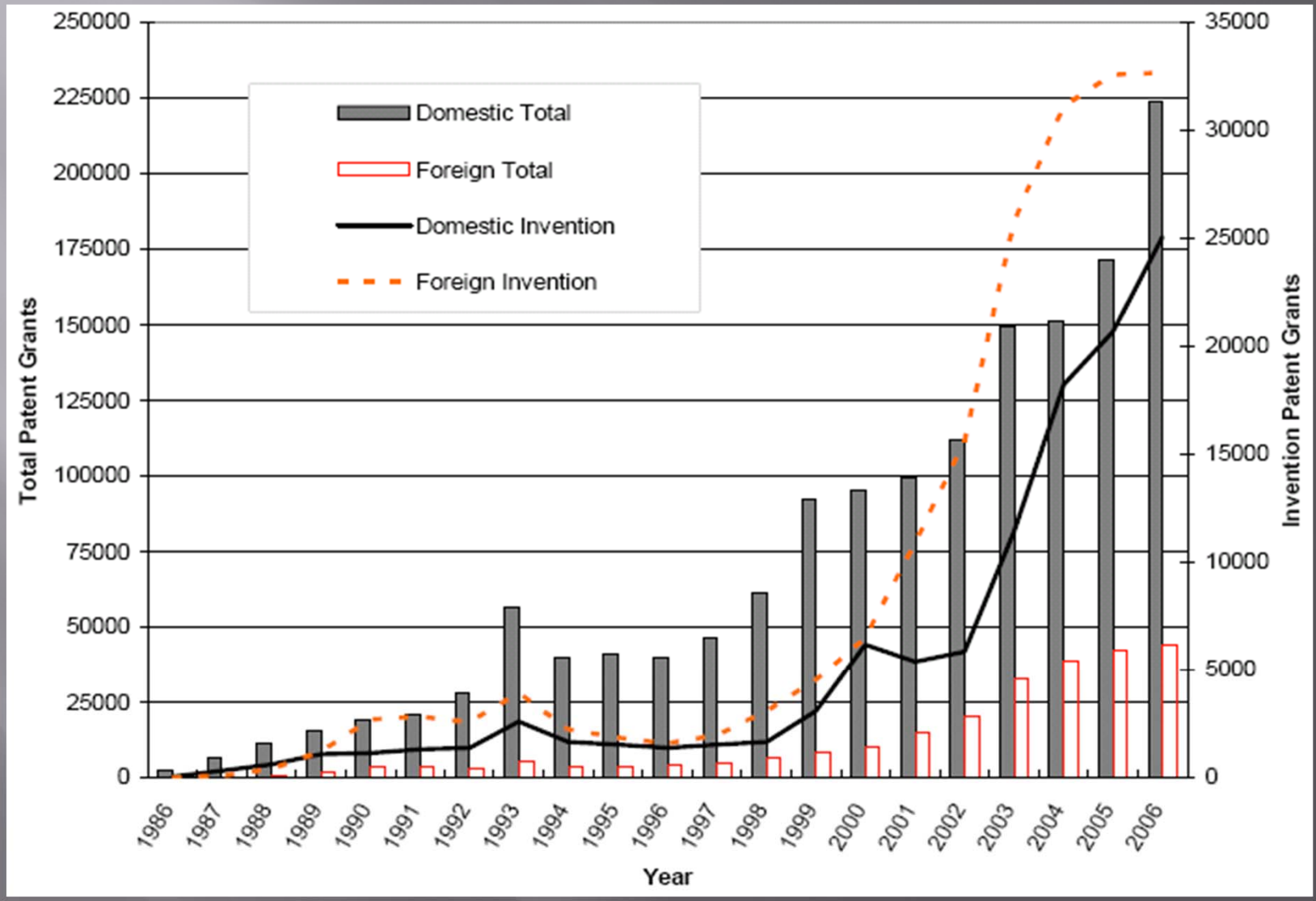
Purpose/structure of the talk

- During the past decade, China has exhibited a surge in patent activity – what has driven that surge?
- Specifically examine:
  - the drivers of China's rising R&D intensity,
  - the impacts that R&D and FDI have on patenting behavior,
  - firm-level motivations for patenting.
- Use both large-scale firm-level data sets and survey data to examine these links.

Take aways?

- Foreign impacts on domestic firm innovation capabilities are very substantial.
- The impacts operate through multiple channels.
- An indigenous innovation initiative runs the risk of slowing the breadth and depth of indigenous technological advance, which is globally integrated and based on dynamic comparative advantage.
- The motives for innovation and patenting in China and abroad appear to be converging, i.e. harmonizing.
- Unanswered questions….

The Surge: Hu and Jefferson, "Great Wall of Patents," JDE (2009)



Update: patenting in 2009/2005
(% change from 2005)

- Total patent applications: 976,686/476,264 (105%)
- Invention patents: 314,573/173,327 (81%)
  - % Granted in 2009: 128,489/314,573 (41%)
    - domestic – 65,391/229,096 (29%)
    - foreign – 63,098/85,477 (74%)
- Utility model patent applications: 310,771/139,566 (123%)
  - % Granted in 2009: 203,802/310,771 (66%)
    - domestic – 202,113/308,861 (65%)
    - foreign – 1,689/1,910 (88%)
- Design patent applications: 163,371/351,342 (115%)
  - % Granted in 2009: 249,701/351,352 (71%)
    - domestic – 234,282/339,654(69%%)
    - foreign – 15,419/11,688 (132%)

Key drivers of patenting

- R&D/GDP
  - The specific drivers of R&D intensification
    - FDI
    - Foreign technology purchases (FTP)
    - Domestic technology purchases (DTP)
- Direct impact of FDI
- Motives for patenting

Hu, Jefferson, Qian, "The Great Wall of Patents…", JCE, 2009

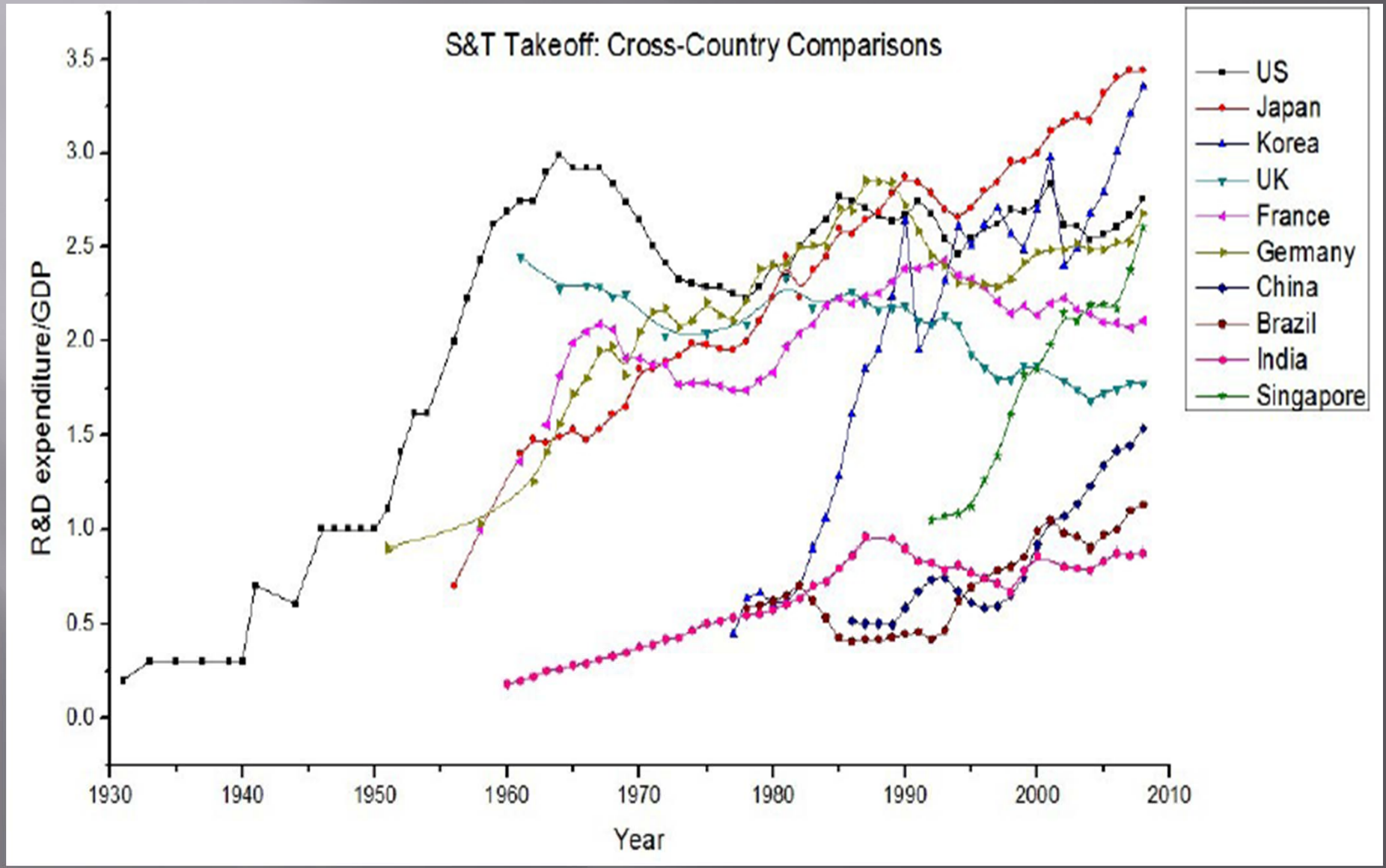
	(1) baseline	(2) FDI	(3) ownership	(4) industry
Log(R&D)	0.076**	0.064**	0.062**	0.066**
	(0.007)	(0.007)	(0.007)	[0.006]
$[Log(R\&D)]^2$	0.021**	0.018**	0.017**	0.018**
	(0.002)	(0.002)	(0.002)	(0.001)
Log(labor)	0.108**	0.209**	0.301	0.329**
	(0.026)	(0.030)	(0.034)	(0.038)
Industry FDI	-	**1.510****	**1.360****	**1.496****
	-	**(0.155)**	**(0.153)**	**(0.199)**
collective	-	-	1.250**	1.003**
	-	-	(0.158)	(0.114)
private	-	-	1.130**	0.936**
	-	-	(0.200)	(0.187)
jointly owned	-	-	0.431	0.315
	-	-	(0.342)	(0.337)
public	-	-	0.722**	0.585*
	-	-	(0.098)	(0.100)
foreign	-	-	0.430**	0.390**
	-	-	(0.106)	(1.102)
HMT	-	-	0.000	0.511**
	-	-	(0.735)	(0.108)
Other	-	-	0.316**	0.283**
	-	-	(0.088)	(0.087)
Industry dummies	no	no	no	**yes**
1996	0.075	0.063	-0.027	-0.038
	(0.120)	(0.119)	(0.114)	(0.108)
1997	0.358*	0.336*	0.228	0.200
	(0.156)	(0.156)	(0.149)	(0.143)
1998	0.532**	0.408**	0.320	0.295*
	(0.150)	(0.153)	(0.153)	(0.145)
1999	0.643**	0.503**	0.386**	**0.338***
	(0.122)	(0.125)	(0.122)	**(0.115)**
2000	0.818*	0.650**	0.524**	**0.477****
	(0.109)	(0.107)	(0.108)	(0.105)
2001	**0.896****	**0.683****	**0.565****	**0.519****
	(0.105)	(0.104)	(0.106)	((0.106)
Observations	133016	130296	130287	130287
Log likelihood	-83045.52	-77462.18	-76047.21	-72082.09

The impact of patenting: R&D vs. FDI

Hu, Jefferson, and Qian: "The Great Wall of Patents:…" (JDE, 2009)

- Research objective: to explain the determinants of China's patent surge, 1995-2001.
- Key findings:
  - Domestic firms: R&D significantly affects patenting, but relative to the OECD countries, the impact is weak;
  - Foreign firms – R&D has no impact on patenting.
  - Direct impacts of concentrations of FDI on patenting:
    - have a strong impact on patenting in domestic firms;
    - the impact on non-SOEs is stronger; and
    - Particularly strong in FDI-intensive industries such as electric machinery, transportation equipment and chemical industries.

China's S&T takeoff – R&D intensification



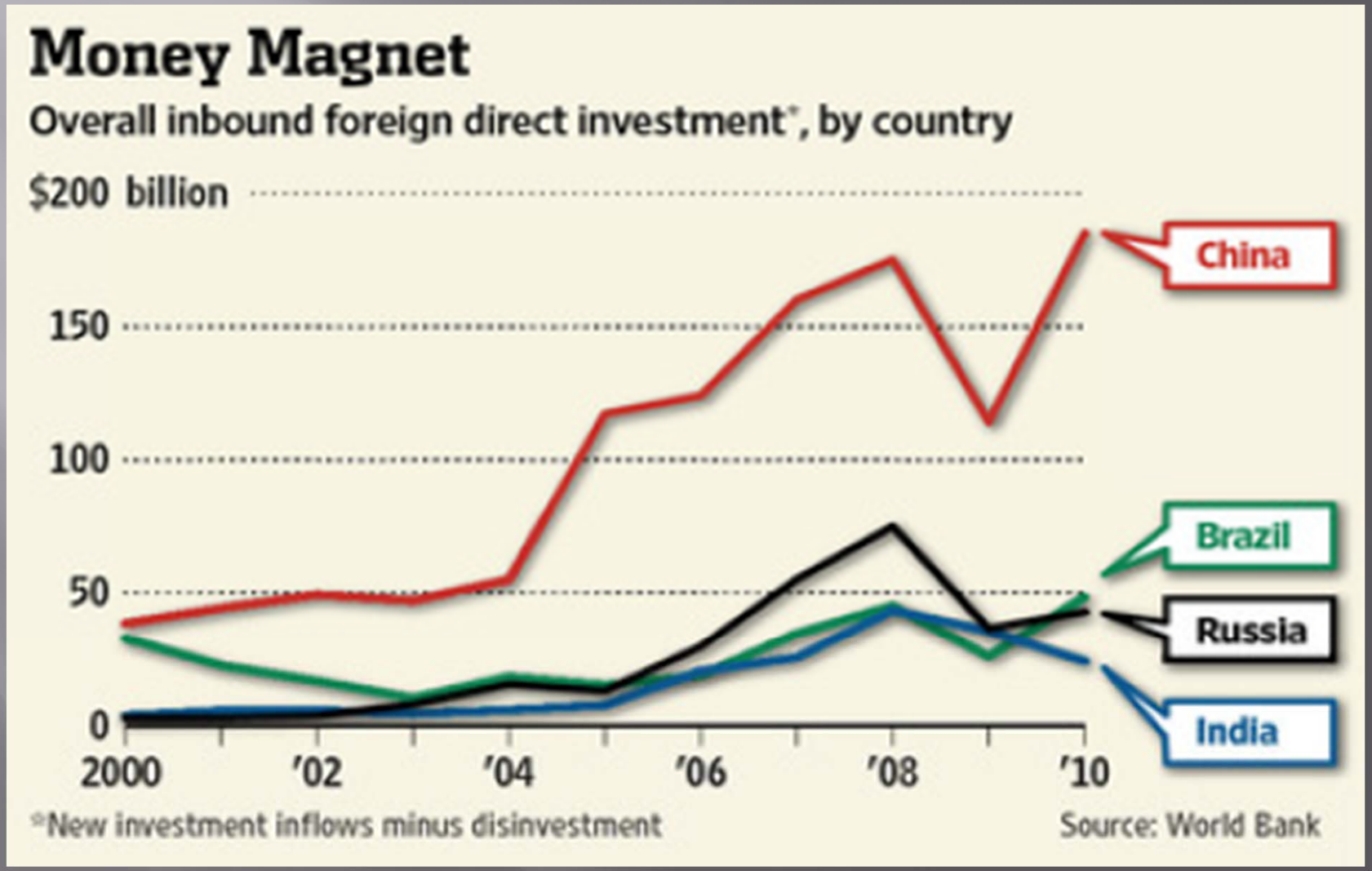
Recent measures…

- R&D/GDP
  - 2009: 1.70%
  - 2005: 1.32%
- % basic to total R&D
  - 2009: 4.6%
  - 2005: 5.3%
- % government funds to total R&D
  - 2009: 23.0%
  - 2005: 26.3%

Drivers of R&D intensification – Gao and Jefferson, Asia Pacific Business Review, 2007

- The factor income share of technology-intensive inputs rises in relation to that of production labor (e.g. autos vs. bikes, western medicine vs. traditional medicine).
- The productivity of R&D labor rises (with the addition of complementary inputs (e.g. schooling, FDI); holding constant the supply of technological opportunity),
- The scale effects of available knowledge grows, i.e., an enlarged base of technological opportunity enables the efficiency of R&D activity to rise (e.g. FDI); and
- Subsidies to R&D labor increase, including, possibly, a rise in the productivity of R&D labor in relation to its wage.

The role of FDI in driving R&D intensification: China in relation to the other BRICs (WSJ, 1/2/12)



Deng and Jefferson, 1997-2004 (2010)

Table 7 Regression models on R&D intensity

	Dependent variable: R&D Intensity, ln(R&D/VA)					
Independent variables:	**OLS**		**Tobit**		**Random-effects Tobit**	
	(1)	(2)	(3)	(4)	(5)	(6)
foreign entry, (t-1)	0.023**	-0.005	0.104***	0.125***	0.063**	0.070**
	(0.012)	(0.016)	(0.030)	(0.031)	(0.030)	(0.031)
technological distance, (t-1)	0.031***	-0.029	0.106***	0.109***	0.095***	0.088***
	(0.005)	(0.042)	(0.012)	(0.012)	(0.013)	(0.014)
entry(t-1) * distance(t-1)	**-0.017****	0.002	**-0.074*****	**-0.086*****	**-0.047****	**-0.036***
	(0.009)	(0.012)	(0.022)	(0.023)	(0.022)	(0.023)
capital-labor ratio, K/L		-0.001		0.023***		0.021***
		0.004		0.003		0.004
firm scale, L		-0.001		0.027***		0.029***
		0.007		(0.002)		(0.003)
constant	-0.017***	0.063	-0.196***	-0.482***	-0.192***	-0.498***
	(0.006)	(0.070)	(0.015)	(0.029)	(0.016)	(0.039)
year dummies	No	Yes	No	No	No	Yes
firm fixed/random effects	No	Yes	No	No	Yes	Yes
number of observations	4,512	4,512	4,512	4,512	4,512	4,512

Notes: *** (**, *) indicates statistical significance at the 1 (5, 10)-percent level.

The impact of foreign entry on R&D

- Deng and Jefferson (2011) – Foreign entry (FE) motivates domestic firms to spend more on R&D.
- A separation effect, i.e. separate the LMEs into high productivity-low productivity groups, as measured by their distance from the FE technology frontier.
- As a result of FE, both groups:
  - spend more on R&D;
  - however, the high-productivity firms increase their R&D spending by considerably more than the low-productivity firms.
- Also, as a result of FE:
  - The high-productivity firms patent more;
  - The low-productivity firms patent less.

More on the (direct and indirect) impacts of FDI on patenting

H, J,Q: "Great Wall of Patents…"

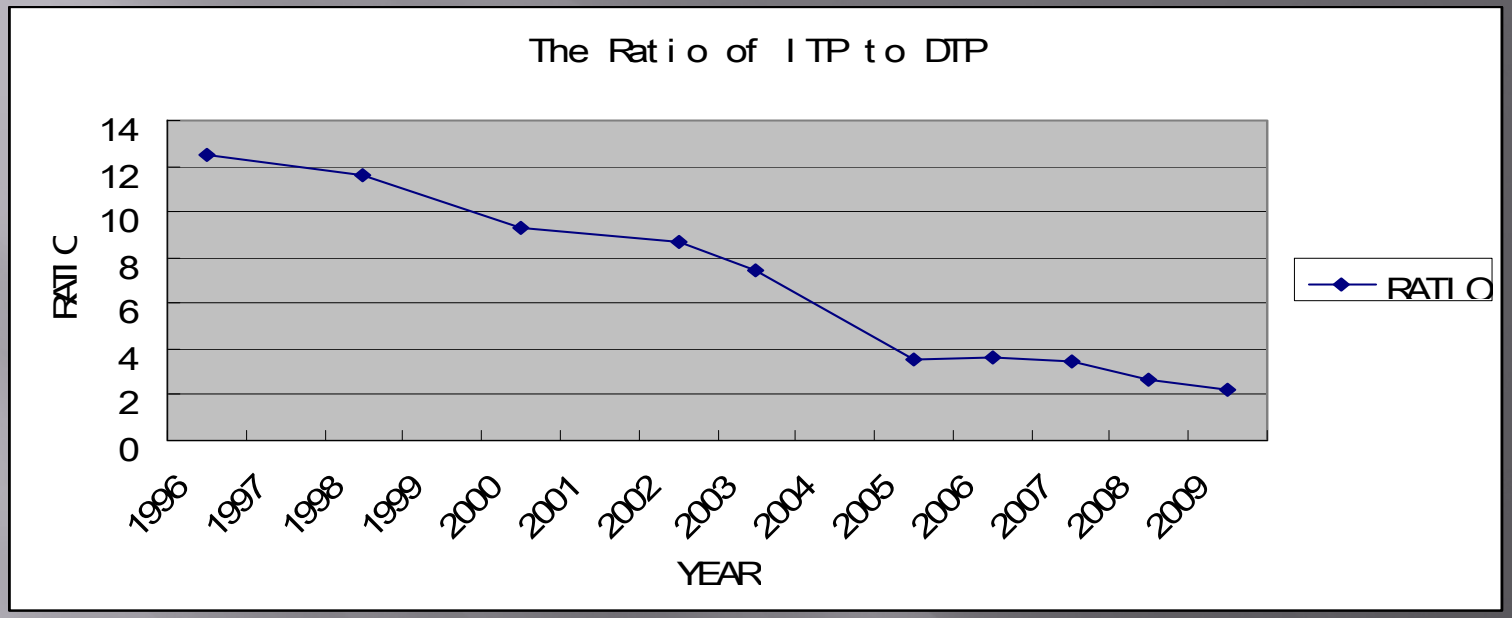
- The channel of effect on the patent surge is ambiguous:
  - More fish in the technology pond, i.e., new innovation opportunities, or
  - Strategic patenting of already developed technologies or lower quality innovations, i.e., higher propensity to patent?
- Do not distinguish whether the FDI impacts are on higher quality invention patents or lower quality utility patents (the later have grown more quickly).
- Hence, the net effect of FDI on Chinese patenting may be ambiguous.

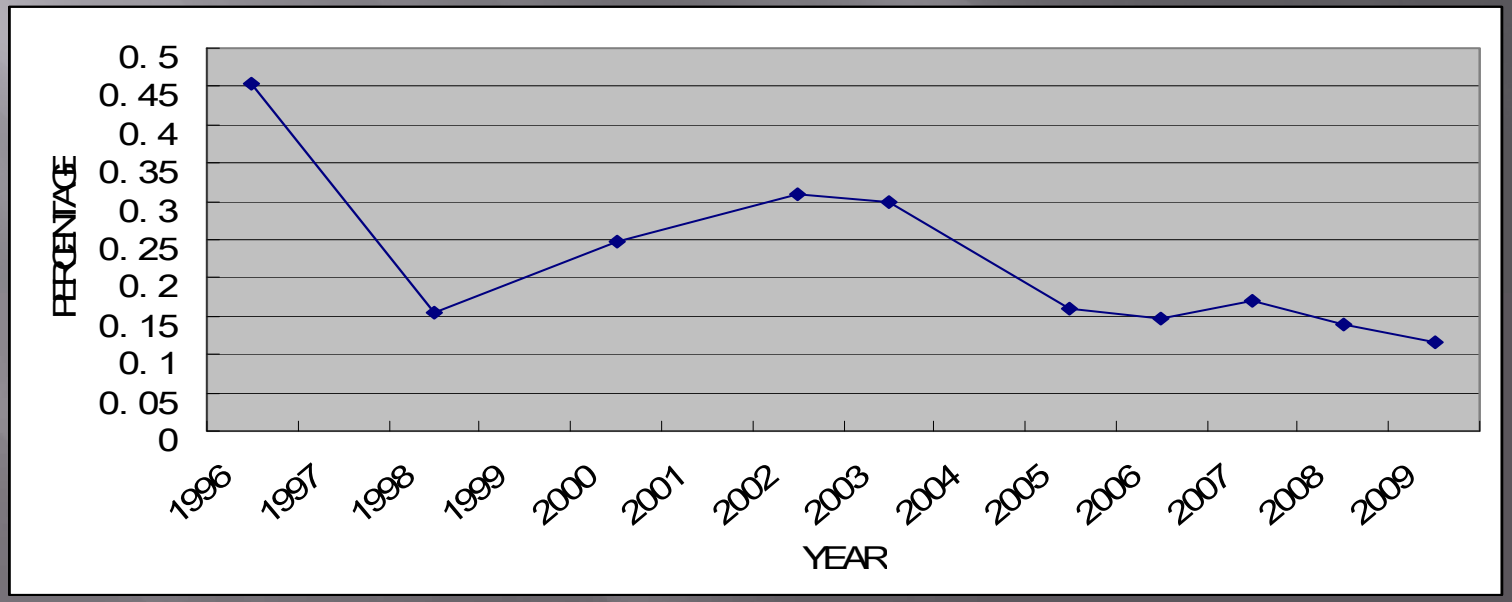
The Impact of technology purchases on R&D
Hu, Jefferson and Qian (REStat, 2005)

- Use the LME data set covering 1995-1999.
- Key findings:
  - Firms that purchase foreign technology (FTP) also tend to maintain internal R&D;
  - For domestic firms, R&D and FTP are strongly complementary;
  - They are not complementary for foreign-invested firms;
  - An increase in FTP alone has no impact on firm productivity;
  - a 1% increase in both R&D spending and FTP is predicted to lead to a 1% increase in firm productivity with most of the increase coming from the interaction of R&D with FTP.

The ratio of FTP:DTP and the percentage of FTP/GDP*

*FTP=ITP





Implications for the indigenous innovation initiative

- Clear evidence that FDI is motivating/enabling domestic firms to patent – both directly and indirectly….
- FDI is motivating firms to intensify their R&D spending, which leads to more patenting.
- The purchase of foreign technology robustly interacts with R&D to enchance the impact and returns to R&D – and hence motivate greater R&D intensity.

What motivates firms to patent – or not patent?
Jefferson, Liu, Ren, IPR survey

- 2009 - ~150 domestic and foreign firms in Beijing;
- 2010 - ~ 150 domestic and foreign firms in Shenzhen;
- Industries:, electronics, mechanical, automobile, chemical information technology, software, communications
- Pooled the Beijing and Shenzhen samples
- Compare results with Levin's Yale (1984) survey and Cohen, Nelson, and Walsh (1994).

Preferred methods for securing IPR

- China: secrecy, lead time, domestic patenting (both product and process innovation), foreign patenting is last for both product and process innovation.
- US: secrecy, lead time, patenting (tied with complementary sales/service and manufacturing) – for both product and process innovation.
- Conclusion: For both China and the U.S. – patenting is NOT the method of securing IPR that is used most frequently or viewed as most effective…

Main reason for applying for a patent

- Survey possibilities:
  - limit entry and sales by competitors (blocking)
  - Evaluate personnel achievement
  - Licensing revenue
  - Negotiations
  - Prevent lawsuits
  - Prevent copying
  - Reputation
  - Other (e.g. to secure financing and improve the likelihood of an IPO, as Samuelson-Radar, "The Berkeley Patent Survey," 2010) find in the case of software patenting).

Motives for patenting

- China: Enhance ***reputation,*** followed by ***prevent copying*** and ***prevent lawsuits*** about equal, followed by ***limit entry and sales (blocking);***
- U.S. (CNW and Yale surveys): Both product and process innovation - prevent copying, blocking (limit entry and sales), and prevent lawsuits
- Differences may reflect:
  - Reputation: priority and extensive incentives provided by Chinese government;
  - Prevent lawsuits seemingly receiving less priority in the U.S. survey: somewhat earlier U.S. surveys – 1994 (CNW) and (1984) Yale.

Reasons for not patenting

- Choices:
  - headquarter's rules
  - Importance of the overseas market
  - Ineffectiveness of legal enforcement
  - Insufficient duration of the patent
  - Application and renewal cost too high
  - Legal defense/enforcement costs too high
  - Easy for competitors to invent around the patent
  - Application procedure takes too long
- Chinese survey: ineffectiveness of legal enforcement, ease of inventing around, application procedure takes too long.

U.S. comparison

- CNW: Ease of inventing around, difficulty demonstrating novelty, disclosure requirement.
- Berkeley survey: Cost of obtaining and enforcing the patent; ease of inventing around
- Interpretation: Chinese reasons for not applying for patents are more focused on weaknesses in the patent system – enforcement, duration… (not focused on cost, rather on poor outcomes).

Satisfaction with the IPR system

- Firms in Shenzhen tend to be less satisfied with China's IPR system than those in Beijing; SOEs in Beijing are the most satisfied.
- Firms that are most satisfied with the IPR system are more likely to license their IP to other companies, while those that are less satisfied retain the IP within their firm boundaries – self-use, transfer to parent company, or establish a joint venture.

Strategic patenting – discourage litigation; facilitate litigation/settlements; block entry

- Strategic patenting seems to be one arena in which is taking place.
- Company survey: The R&D manager (ZTE?) reported that one of the firm's motives for its prolific patenting was to "protect" itself against the aggressive strategic patenting of foreign firms.

Conclusions I

- Drivers of patenting in China differ from the U.S. and other OECD countries:
  - In China. R&D plays a more limited role, particularly for foreign firms.
  - FDI and foreign entry purchases play a much larger role (both directly and by motivating R&D)
- Foreign factors play a critical role in motivating China's R&D intensification – and patenting:
  - FDI has robust impacts on R&D spending but firm heterogeneity matters.
  - Foreign (and domestic) technology purchases also enhance the returns to R&D, thereby motivating its intensification.

Conclusions II

- The incentive structure for seeking IP protection and patents in China and the U.S. are largely similar:
  - Relative importance/frequency of means for securing IPR similar – secrecy, lead, then patenting.
  - Motives for patenting similar – perhaps more tilted toward reputation and strategic reasons in the Chinese survey.
  - Motives for not patenting differ. Differences reflecting the quality of the patent systems and ownership structures.
- While there are differences, most are matters of degree – a different world than what the survey would have found 27 years ago (i.e. 1984 before the patent law went into effect).